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(54) **TURBINE EXHAUST WATER RECOVERY SYSTEM**

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F25B 27/00 (2006.01)

(52) **U.S. Cl.** **62/238.3**; 62/304; 60/39.5; 261/88

(58) **Field of Classification Search** 62/91–94, 62/238.3, 274, 283, 288, 291, 304; 60/39.5; 261/88; 96/126, 134, 277
See application file for complete search history.

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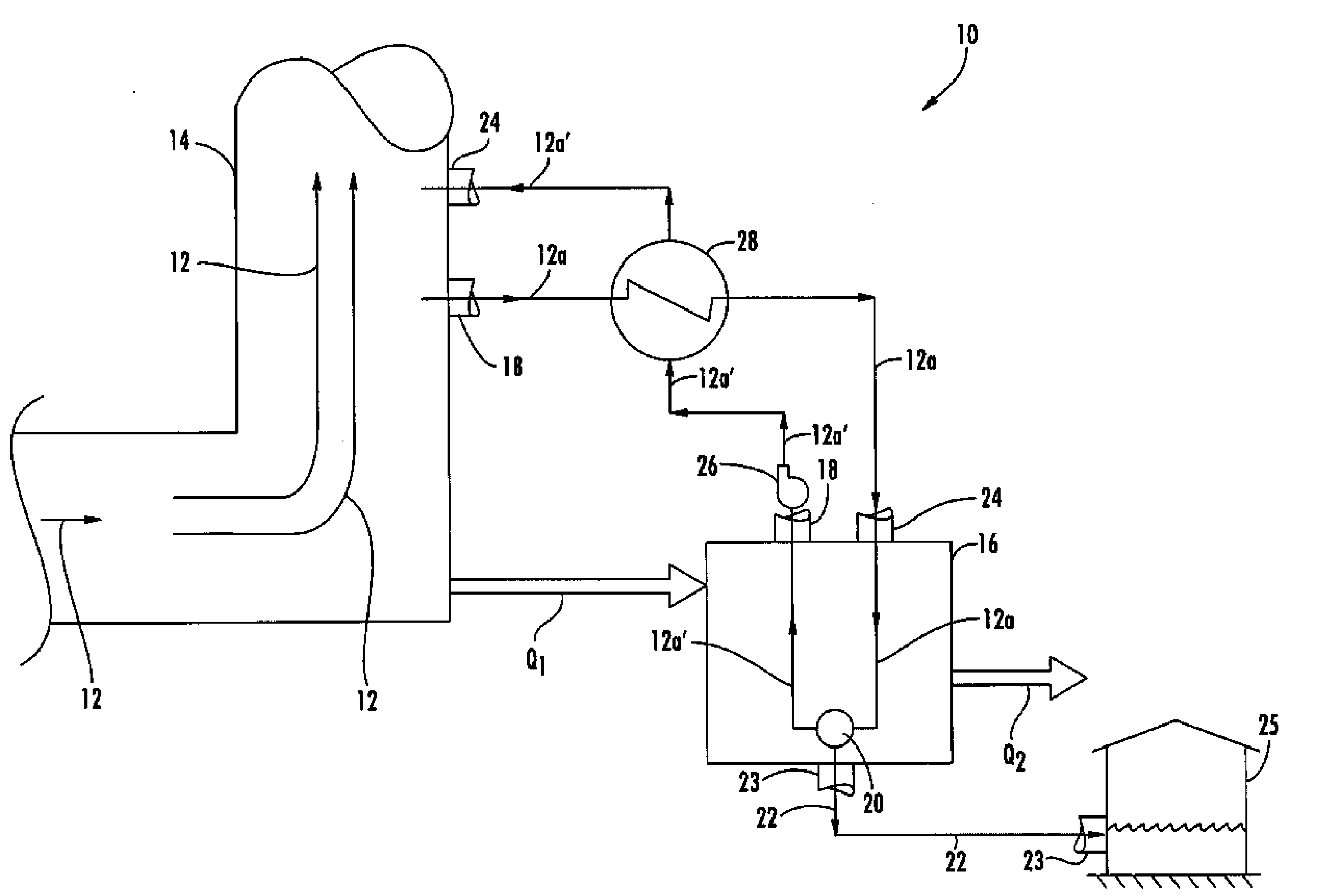
(57) **ABSTRACT**

The exhaust gas of a turbine engine can include water vapor. Aspects of the invention relate to various systems for recovering water from the exhaust gas of a gas turbine engine. In one system, a portion of the exhaust gas can be routed to an absorption chiller. In another system, a portion of the exhaust gas can be routed to a direct contact heat exchanger. In a third system, a portion of the exhaust gas can be routed to a fin-fan cooler. In each of these systems, the portion of gas can be cooled below its dew point temperature to release a portion of its humidity as liquid water. Aspects of the invention can be used with the turbine exhaust of simple and combined cycle power plants. A water recovery system according to aspects of the invention can minimize or eliminate a power plant's dependence on local water sources.

20 Claims, 3 Drawing Sheets



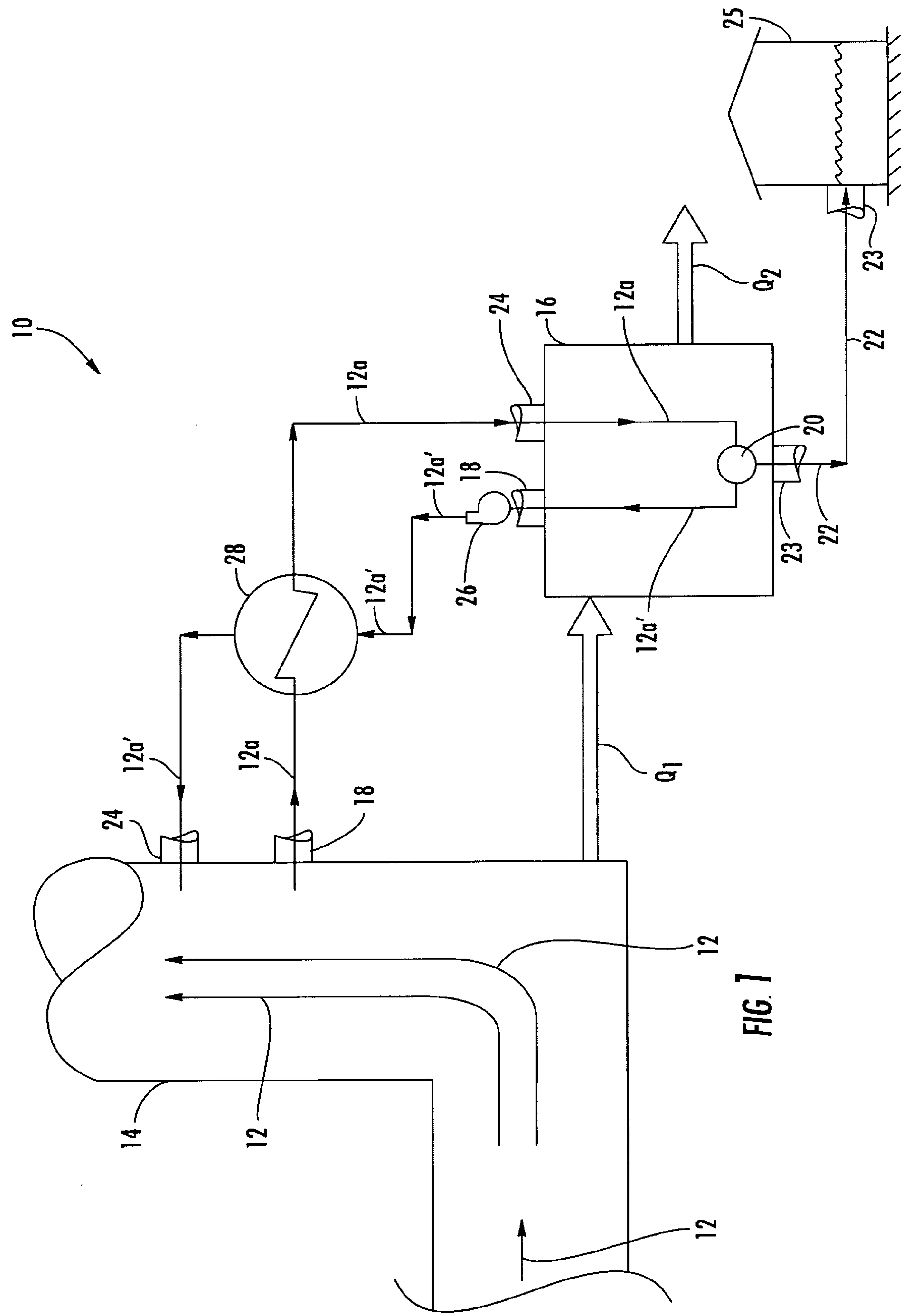


FIG. 1

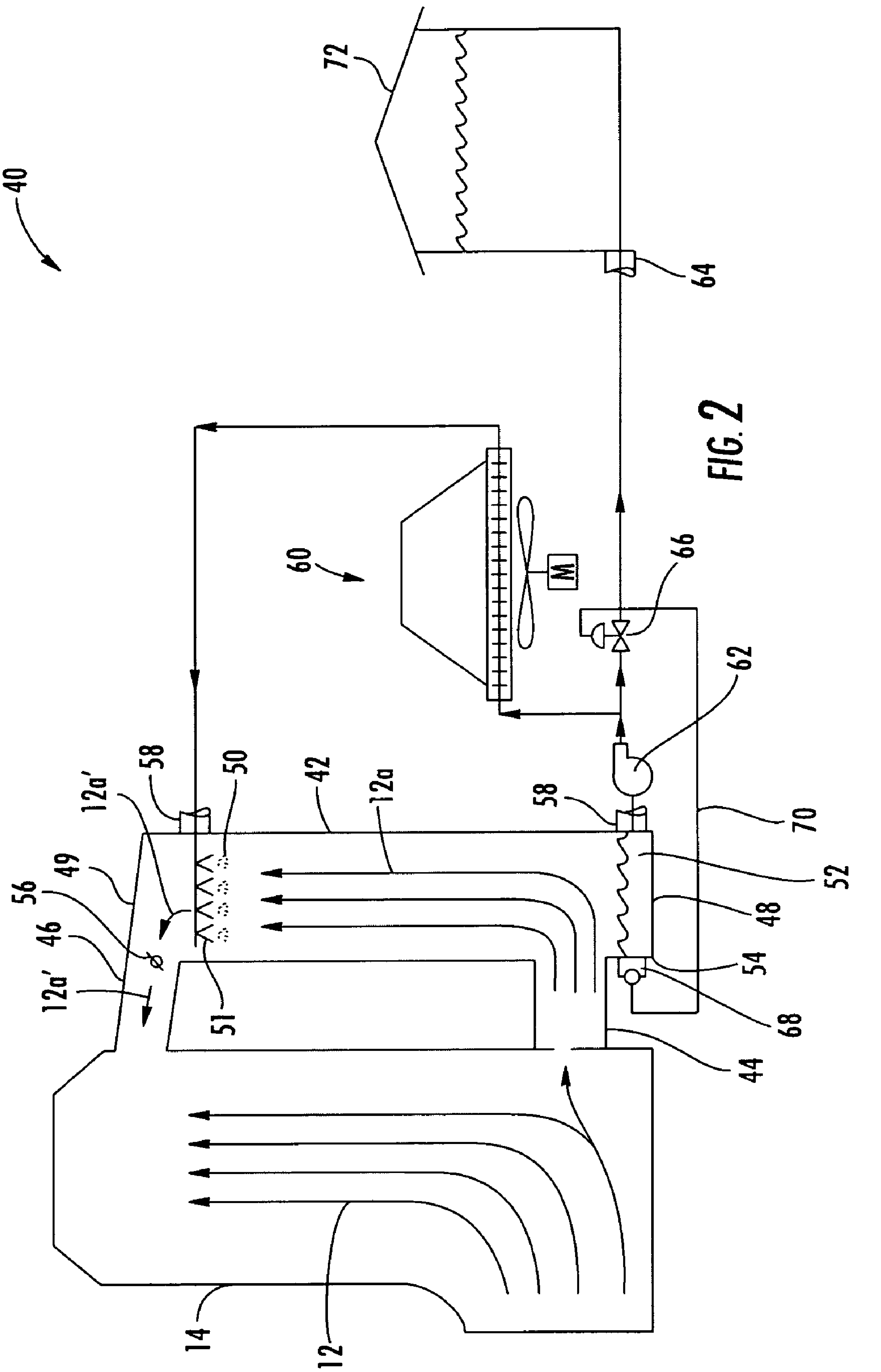

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FIG. 2

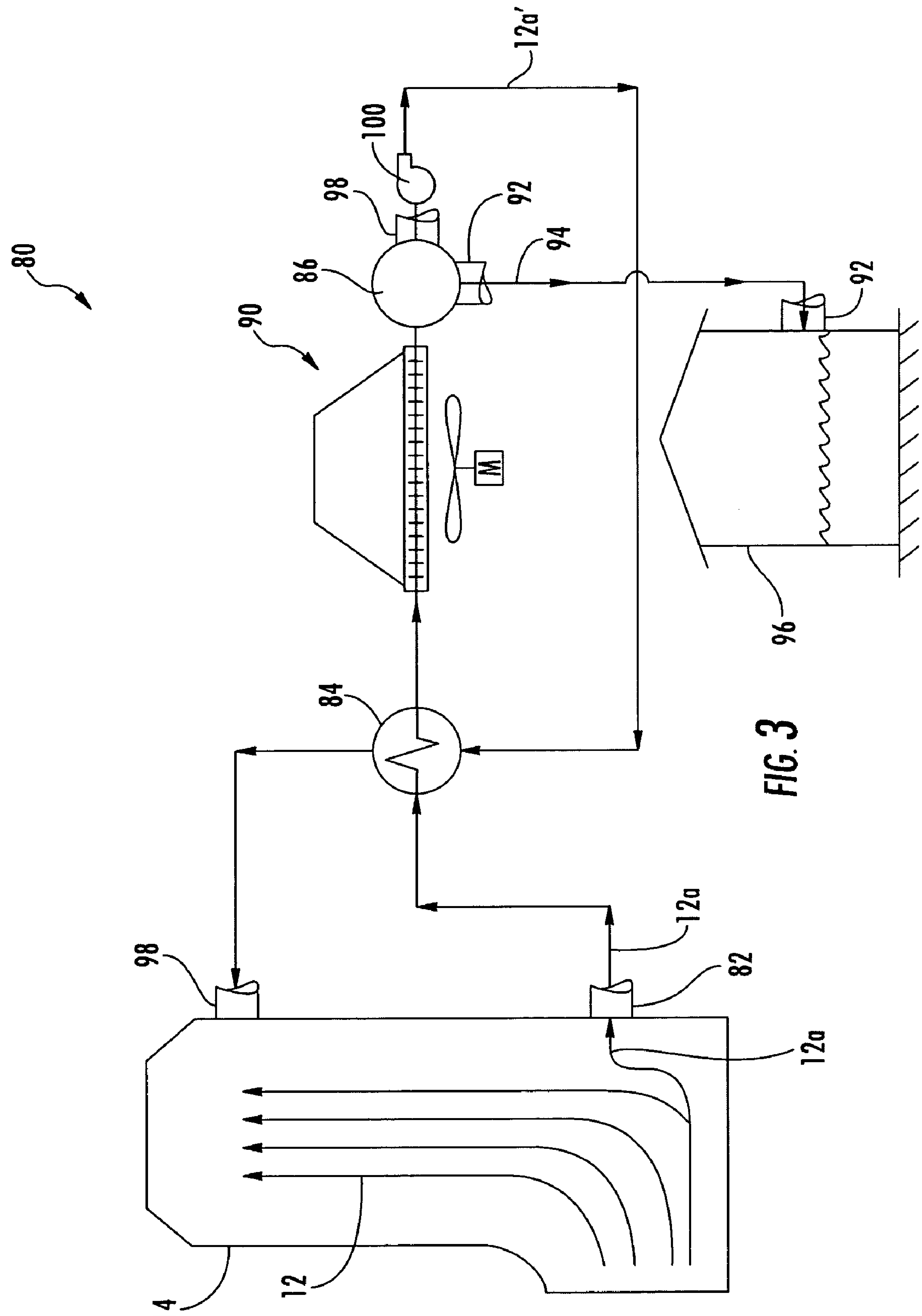

FIG. 3

TURBINE EXHAUST WATER RECOVERY SYSTEM

FIELD OF THE INVENTION

The invention relates in general to gas turbine engines and, more particularly, to the exhaust of a gas turbine engine.

BACKGROUND OF THE INVENTION

Water is a scarce resource in certain areas of the world. For power plants located in such areas, there may be an insufficient amount of freely available water to support plant needs. Consequently, power plants have obtained water from other sources, such as rivers or wells. Some power plants have resorted to extracting and desalinizing ocean or brackish water. However, the lack of available water in some areas has dissuaded local decision-makers from building power plants.

The dependence of a power plant on water can restrict the geographic possibilities for power plants to those areas where water is locally available, a permit can be obtained, and/or there is a reduced possibility of intervention from environmental interests. Thus, there is a need for system that can minimize these restrictions and expand the geographic potential for power plant sites irrespective of local water availability.

SUMMARY OF THE INVENTION

Exhaust gas from a turbine engine is usually discharged through an exhaust duct. The turbine exhaust gas has an associated first temperature, and one constituent of the turbine exhaust gas is water vapor. Aspects of the invention relate to systems for recovering water from the turbine exhaust gas.

A first water recovery system according to aspects of the invention includes an absorption chiller. In one embodiment, the absorption chiller can be primarily powered by the heat energy of the exhaust gas in the exhaust duct. A supply conduit extends between and in fluid communication with the exhaust duct and the absorption chiller. The supply conduit receives a portion of the turbine exhaust gas and routes the gas to the absorption chiller. The absorption chiller reduces the temperature of the turbine exhaust gas to less than the dew point of the gas. As a result, at least some of the water vapor in the turbine exhaust gas condenses. The system includes a separator operatively associated with the absorption chiller. The separator removes at least a portion of the condensed water from the exhaust gas.

The system can further include a discharge conduit that is in fluid communication with and extends from the absorption chiller. The discharge conduit can route the gas out of the absorption chiller. The discharge conduit is in fluid communication with the exhaust duct. Thus, the gas can be returned to the exhaust duct. In one embodiment, a blower can be provided along the discharge conduit to facilitate the movement of the gas along the discharge conduit.

The system can further include a heat exchanger. The supply conduit and the discharge conduit can pass in heat exchanging relation through the heat exchanger such that the temperature of the gas in the supply conduit is reduced below the first temperature prior to entering the absorption chiller. Thus, the effective duty of the absorption chiller can be reduced.

A second water recovery system according to aspects of the invention includes a direct contact heat exchanger. The direct contact heat exchanger has an inlet and an outlet as well as an upper end and a lower end. The lower end is defined at least in part by a sump. Both the inlet and the outlet are in fluid communication with the exhaust duct. A portion of the turbine exhaust gas is received in the inlet. In one embodiment, the direct contact heat exchanger can be substantially vertical. In such case, the outlet is provided at a vertically higher elevation than the inlet. A damper can be operatively associated with the outlet of the direct contact heat exchanger. The damper can selectively regulate the flow of the gas through the outlet.

One or more water dispensing devices are provided in the direct contact heat exchanger near the upper end. The water dispensing device is adapted to introduce water into the flow of the turbine exhaust gas. When the water engages the exhaust gas, the temperature of the exhaust gas is reduced below the first temperature so as to condense at least a portion of the water vapor in the exhaust gas. The condensed water collects in the sump.

The system can include a return conduit, which can be in fluid communication with the sump as well as the one or more water dispensing devices. The return conduit can route water from the sump to the one or more water dispensing devices for introduction to the turbine exhaust gas in the direct contact heat exchanger. A pump can be provided along the return conduit to facilitate the flow of water through the return conduit. A heat exchanger can be provided along the return conduit for reducing the temperature of the water to no more than about the ambient dry bulb temperature. The heat exchanger can be, for example, a fin-fan cooler.

The return conduit can include a branch conduit, which can be located upstream of the heat exchanger. Thus, water can flow into the branch conduit for use elsewhere. The branch conduit can be in fluid communication with a storage tank where the water can be stored for later use.

A control valve can be provided along the branch conduit. The control valve can selectively permit and prohibit the flow of the water through the branch conduit. There can also be a sensor for activating and deactivating the valve. The sensor can be connected to the sump and can be responsive to the level of the water in the sump. The sensor can be operatively associated with the control valve such that the sensor activates the control valve when the level of the water in the sump reaches a predetermined level.

A third stack water recovery system includes a separator, a supply conduit and a discharge conduit. The supply conduit extends between and in fluid communication with the exhaust duct and the separator. The supply conduit receives a portion of the turbine exhaust gas and routes the gas to the separator. The discharge conduit extends between and in fluid communication with the separator and the exhaust duct. The gas in the discharge conduit reenters the exhaust duct for release into the atmosphere. In one embodiment, a blower can be provided along the discharge conduit.

The system also includes a first and second heat exchanger. The first heat exchanger is provided along the supply conduit upstream of the separator. The supply conduit and the discharge conduit pass in heat exchanging relation through the first heat exchanger. Thus, the first heat exchanger reduces the temperature of the exhaust gas in the supply conduit below the first temperature. The second heat exchanger, which can be a fin-fan cooler, is provided along the supply conduit downstream of the first heat exchanger and upstream of the separator. The second heat exchanger further reduces the temperature of the turbine exhaust gas to a temperature below the dew point of the gas. Thus, at least some of the water vapor in the turbine exhaust gas can condense, and the separator can removes at least a portion of the condensed water from the gas.

In one embodiment, the system can further include a storage tank. A conduit can extend between and in fluid communication with the separator and the storage tank. Thus, the water can be routed to the storage tank for later use.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic view of a first water recovery system according to aspects of the invention.

FIG. **2** is a diagrammatic view of a second water recovery system according to aspects of the invention.

FIG. **3** is a diagrammatic view of a third water recovery system according to aspects of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of the invention present systems for extracting water from turbine exhaust gases. Embodiments of the invention will be explained in the context of various possible systems, but the detailed description is intended only as exemplary. Embodiments of the invention are shown in FIGS. **1**–**3**, but the present invention is not limited to the illustrated structure or application.

In a gas turbine engine, fuel and air can be mixed and combusted to produce high pressure, high velocity gas. The gas can be routed to the turbine section of the engine where energy can be extracted from the gas. After exiting the turbine, the gas can be discharged to the environment through an exhaust stack or other exhaust duct. When a hydrocarbon-based fuel, such as natural gas, is used in the combustion process, one constituent of the combustion gas is water vapor. In one engine system, water vapor can be about five percent of the turbine exhaust mass flow. According to aspects of the invention, this water can be recovered from the exhaust gas for subsequent use, instead of being released to the atmosphere. Embodiments of the invention are particularly suited for extracting water from the exhaust of a turbine in a simple cycle power plant, but aspects of the invention can also be used to extract water from the turbine exhaust in a combined cycle power plant.

One water recovery system **10** according to aspects of the invention is shown in FIG. **1**. Exhaust gas **12** from the turbine (not shown) are routed through an exhaust stack or other exhaust duct **14**. The exhaust duct **14** can have any of a number of shapes and sizes, and the exhaust duct **14** according to aspects of the invention is not limited in either of these regards. Likewise, the exhaust duct **14** can be made of any of a number of materials. The exhaust duct **14** can be arranged so as to be substantially vertical, but other orientations are possible.

The exhaust duct **14** can be configured to route a portion **12***a* of the exhaust gas **12** to an absorption chiller **16**. In one embodiment, a supply conduit **18** can extend between the exhaust duct **14** and the absorption chiller **16** so that the absorption chiller **16** can be in fluid communication with the exhaust duct **14**. The supply conduit **18** can be directly or indirectly connected to the exhaust duct **14**. Similarly, the supply conduit **18** can be directly or indirectly connected to the absorption chiller **16**. The supply conduit **18** can be formed by one or more components including, for example, pipes or ducts.

According to aspects of the invention, the absorption chiller **16** can be used to cool the portion of the exhaust gas **12***a*, as will be explained later. Absorption chillers are generally known, so their manner of operation will not be explained herein. The system **10** can further include a separator **20** to facilitate the removal of liquid water from the portion of exhaust gas **12***a*. The separator **20** can be provided inside of the chiller **16**, or it can be provided outside of the chiller **16**. There are various methods by which the separator **20** can remove liquid water from the portion of exhaust gas **12***a*. For example, the separator **20** can reduce the velocity of the gas **12***a* flowing through the absorption chiller **16**, thereby allowing the force of gravity to settle out the water. Alternatively, the separator **20** can remove liquid water by inertial separation, an agglomerator, or any other suitable method.

Regardless of the particular separation method used, water **22** can be collected and can flow from the absorption chiller **16** and/or the separator **20** to a process user or a storage device. A discharge conduit **23** can be provided to facilitate flow of the water **22** from the absorption chiller **16** and/or the separator **20**. In one embodiment, a discharge conduit **23** can be connected, directly or indirectly, at one end to the absorption chiller **16** and/or the separator **20**. At an opposite end, the discharge conduit **23** can connect, directly or indirectly, to a storage tank **25**. Thus, it will be appreciated that the storage tank **25** can be in fluid communication with the absorption chiller **16** and/or the separator **20**. The discharge conduit **23** can be formed by one or more components including, for example, pipes or ducts.

The cooling process of the absorption chiller **16** can be primarily driven by heat energy rather than mechanical energy. Because the exhaust gas **12** can be hot, such as in the range of about 1000 to about 1200 degrees Fahrenheit, the excess heat energy of the exhaust gas **12** can be used to power the absorption chiller **16**. As shown in FIG. **1**, heat energy Q**1** from the exhaust gas **12** in the exhaust duct **14** can be delivered to the absorption chiller **16** to cool the gas **12***a* therein. Heat Q**2**, which includes at least heat energy Q**1** as well as any heat extracted from the gas **12***a*, can be rejected to the atmosphere.

After passing through the absorption chiller **16**, the less humid gas **12***a*' can be routed back to the exhaust duct **14**. Preferably, the gas **12***a*' reenters the exhaust duct **14** downstream of where the gas **12***a* was initially diverted to the absorption chiller **16**, that is, downstream of the supply conduit **18**. However, the gas **12***a*' can reenter the exhaust duct **14** at other locations as well. The absorption chiller **16** can be in fluid communication with the exhaust duct **14** by a return conduit **24**. The return conduit **24** can extend between the absorption chiller **16** and the exhaust duct **14**. The return conduit **24** can be directly or indirectly connected at one end to the exhaust duct **14**. Similarly, the return conduit **24** can be directly or indirectly connected at the other end to the absorption chiller **16**. The return conduit **24** can be formed by any of a number of components including, for example, one or more pipes, ducts, or fittings. A blower **26** can be provided along the return conduit **24** to facilitate the movement of the gas **12***a*' through the return conduit **24** and toward the exhaust duct **14**. Preferably, the blower **26** is located along the return conduit **24** at a point where the gas **12***a*' is coldest, such as near the absorption chiller **16**.

While the supply conduit **18** and the return conduit **24** can be isolated from each other, it is preferred if the conduits **18**, **24** are configured as to be in heat exchanging relation with each other. For example, the supply and return conduits **18**, **24** can pass through a common heat exchanger **28**, as shown in FIG. **1**. As a result, the temperature of the gas **12***a* in the supply conduit **18** can decrease, and the temperature of the gas **12***a*' returning to the exhaust duct **14** in the discharge conduit **24** can increase. Such an arrangement can be beneficial in that the effective duty of the absorption chiller **16** can be reduced. That is, the gas **12***a* can be initially cooled prior to entering the absorption chiller **16**. Thus, it may be possible to employ a less expensive absorption chiller **16**. Despite this advantage, a system within the scope of the invention may not need such pre-treatment of the exhaust gas **12***a* prior to its entry into the absorption chiller **16**.

One manner in which such the system **10** can be used will now be described. Assuming the exhaust gas **12** is at about 1100 degrees Fahrenheit, the portion of exhaust gas **12***a* can be routed to the absorption chiller **16** through the supply conduit **18**. After passing through the heat exchanger **28**, the temperature of the gases **12***a* can be reduced to, for example, about 300 degrees Fahrenheit. The chiller **16** can further reduce the temperature of the gas **12***a* to about 150 degrees Fahrenheit or otherwise below the dew point temperature of the gases **12***a* to release a portion of its humidity as liquid water. The separator **20** can be used to remove the liquid water **22** from the gas **12***a*. Again, the water **22** can be sent to storage or can be used for other purposes. The gas **12***a*' exiting the chiller **16** can be at about 150 degrees Fahrenheit. After passing in heat exchanging relation with the gas **12***a* in the supply conduit **18**, the temperature of the gas **12***a*' can increase to about 1000 degrees Fahrenheit. The heated dehumidified gas **12***a*' can reenter the duct **14** to be released to the atmosphere. It will be understood that the foregoing description of the operation of the system **10** is provided merely as an example. The temperatures discussed above are provided to facilitate discussion and are not intended to limit the scope of the invention.

Another water recovery system **40** according to aspects of the invention is shown in FIG. **2**. Again, the system **40** includes an exhaust duct **14** through which exhaust gas **12** flows. The previous discussion of the exhaust duct **14** applies equally here.

A direct contact heat exchanger **42** can be in fluid communication with the exhaust duct **14**. The direct contact heat exchanger **42** can have an inlet **44** and an outlet **46**, each of which is in fluid communication with the exhaust duct **14**. The heat exchanger can be arranged in various ways. In one embodiment, the direct contact heat exchanger **42** can be a substantially vertically elongated duct. The inlet **44** can be substantially vertically lower than the outlet **46**. In one embodiment, the inlet **44** can be located near the vertically lower end **48** of the heat exchanger **42** and/or the exhaust duct **14**.

A portion **12***a* of the hot exhaust gas **12** in the exhaust duct **14** can be diverted into the direct contact heat exchanger **42** through the inlet **44**. As the gas **12***a* travels through the heat exchanger **42**, liquid water can be introduced into the flow path of the gas **12***a*. Liquid water droplets **50** can be sprayed or otherwise injected into the heat exchanger **42**. Preferably, the water **50** is introduced near the vertically upper end **49** of the heat exchanger **42**. The water **50** can be introduced by a water dispensing device **51**, which can be one or more injectors, shower heads, sprayers and/or misters. Ideally, the water **50** is cold, such as at about the ambient dry bulb temperature. The falling cold water droplets **50** can contact and cool the gases **12***a* to a temperature at or below the dew point of the gas **12***a* so as to condense the water vapor out of the gases **12***a*. Water **52**, which includes the water droplets **50** and condensed water from the gas **12***a*, can collect in a sump **54** that can form at least a part of the vertical lower end **48** of the heat exchanger **42**. The continuing exhaust gas **12***a*' can flow back into the exhaust duct **14** through the outlet **46** where it can mix with the other duct gas **12** and be released to the atmosphere. While the foregoing discussion of the direct contact heat exchanger **42** has been in connection with a substantially vertical duct, the direct contact heat exchanger **42** according to aspects of the invention can have any of a number of configurations. For instance, the direct contact heat exchanger **42** can be a substantially elongated horizontal duct. It will be understood that a wide range of configurations for the direct contact heat exchanger **42** are within the scope of the invention.

A damper **56** can be provided in or near the outlet **46** of the heat exchanger **42** to control the flow of the gas **12***a*' out of the heat exchanger **42**, as may be desired based on the local climate or output restrictions. The control damper **56** can be a plate or a valve, such as a butterfly valve. The damper **56** can be any device for controlling the amount of the gas **12***a*' exiting the heat exchanger **42**. The operation of the damper **56** can be manual or motorized.

In one embodiment, a portion of the water **52** in the sump **54** can be routed to a conduit **58** for use in the direct contact heat exchanger **42**. The conduit **58** can be defined by, for example, pipes, ducts and fittings. A heat exchanger can be provided along the conduit. The heat exchanger can be, for example, a fin-fan cooler **60** and can be used to reduce the temperature of the water **52** flowing through the conduit **58**. Preferably, the temperature of the water **52** is reduced to near the ambient dry bulb temperature. A pump **62** can be provided along the conduit **58** to facilitate delivery of the water **52** from the sump **54** to the heat exchanger **42**. After exiting the heat exchanger **42**, the cooled water **52** can be delivered to the direct contact heat exchanger **42**, preferably toward the vertical upper end **49** thereof. The cooled water **52** can be introduced to the portion of exhaust gases **12***a* flowing through the heat exchanger **42** as water droplets **50**, as discussed above.

In addition to being reused in the heat exchanger **42**, the collected water **52** can be stored or used for other purposes. To that end, the conduit **58** can include a branch conduit **64**. A level control valve **66** can be provided along the branch conduit **64** for selectively permitting and prohibiting the flow of water **52** along the branch conduit **64**. The operation of the level control valve **66** can be dependent on the level of water **52** in the sump **54**. In one embodiment, a level sensor **68** can be connected to the sump **54**. The sensor **68** and the valve **66** can be operatively connected in various ways. For instance, the sensor **68** and the valve can be operatively connected by a wire **70**. Alternatively, the sensor **68** and the valve **66** can be operatively connected by telemetry or some other remote communication arrangement. The sensor **68** can be responsive to the level of the water **52** in the sump **54**. When the water **52** in the sump **54** reaches a first predetermined level, the sensor **68** can generate a signal instructing the valve **66** to open. The valve **66** can remain open for a preset amount of time or until the sensor **68** instructs the valve **66** to close, such as when the water level in the sump **54** drops to a second predetermined level.

When the valve **66** opens, the collected water **52** can flow along the branch conduit **64**, which can be facilitated by the pump **62**. The branch conduit **64** can route the water **52** to wherever it is needed. In one embodiment, the water **52** can be exported to a storage tank **72** for later use.

A third water recovery system **80** according to aspects of the invention is shown in FIG. **3**. Again, there is an exhaust duct **14** with exhaust gas **12** from the turbine (not shown) flowing therethrough. The previous discussion of the exhaust duct **14** applies equally here. A supply conduit **82** can extend from the exhaust duct **14**. The supply conduit **82** can be formed by various devices including, for example, pipes, ducts and fittings. A portion or slip stream of the gas **12***a* can enter the supply conduit **82**.

Various devices can be provided in series along the supply conduit **82** including, for example, a first heat exchanger **84**, a second heat exchanger and a separator **86**. The first heat exchanger **84** can be used to decrease the temperature of the portion of gas **12***a* passing therethrough. As will be explained later, the first heat exchanger **84** can facilitate the exchange of heat between the air **12***a* in the supply conduit **82** and the returning air **12***a*' in a discharge conduit **88**. The second heat exchanger can be provided along the supply conduit downstream of the first heat exchanger **84**. The second heat exchanger can be almost any type of heat exchanger, but it is preferred if the second heat exchanger is a fin-fan cooler **90**. The second heat exchanger can be used to further reduce the temperature of the gas **12***a*, such as below the dew point. Thus, the gas **12***a* can release a portion of its humidity as liquid water. The separator **86** can be placed downstream of the second heat exchanger to extract the condensed water from the gas **12***a*. The previous discussion regarding separator **20** in connection with the first system **10** is equally applicable to separator **86**. Water **94** can be collected and can flow from the separator **86** to a process user or a storage device. In one embodiment, a conduit **92** can be in fluid communication with the separator **86** for transporting the collected water **94** to a storage tank **96** or elsewhere.

A discharge conduit **98** can extend from the separator **86** and connect back into the exhaust duct **14**. A blower **100** can be provided along the discharge conduit **98**. The blower **100** can increase the pressure of the gas **12***a*' to help route the gas back to the exhaust duct **14**. Ideally, the blower **100** is located along the discharge conduit **98** at or near where the gas **12***a*' is coldest. For example, the blower **100** can be located just downstream of the separator **86**.

The discharge conduit **98** can be configured to pass through the first heat exchanger **84**. Thus, the gas **12***a*' in the discharge conduit **98** can pass in heat exchanging relation with the gas **12***a* in the supply conduit **82**. Thus, it will be appreciated that the relatively cool gas **12***a*' in the discharge conduit **98** can be used to reduce the temperature of the relatively hot gas **12***a* in the supply conduit **82**. This reduction in the temperature of the gas **12***a* can reduce the duty of the heat exchanger. After passing the first heat exchanger **84**, the gas **12***a*' can reenter the exhaust duct **14** for discharge to the atmosphere.

Any of the above water recovery systems can be used to extract water from the turbine exhaust gases. The recovered water can be used for any of a number of purposes. For instance, the water can be injected into the compressor section of the engine, such as at the inlet, to improve power and efficiency through wet compression. Alternatively or in addition, improved cooling can be achieved by injecting the water into the rotor cooling air circuit. The water can be routed to a cooling tower or can be used as drinking water. It will be appreciated that there are a wide range of possible uses for the recovered water. Further, it will be appreciated that aspects of the invention can expand the geographic possibilities for selecting a power plant site. A power plant having a water recovery system according to aspects of the invention can minimize or eliminate dependence on surface, well or municipal water sources. In addition, such a power plant may not require a permit for withdrawing the water from the environment.

The foregoing description is provided in the context of various possible water recovery systems. It will of course be understood that the invention is not limited to the specific details described herein, which are given by way of example only, and that various modifications and alterations are possible within the scope of the invention as defined in the following claims.

What is claimed is:

1. A water recovery system comprising:

an exhaust duct with a turbine exhaust gas flowing therein, the turbine exhaust gas including water vapor and being at a first temperature;

an absorption chiller;

a supply conduit extending between and in fluid communication with the exhaust duct and the absorption chiller, wherein the supply conduit receives a portion of the turbine exhaust gas and routes the gas to the absorption chiller, wherein the absorption chiller reduces the temperature of the turbine exhaust gas to less than the dew point of the gas, thereby causing at least some of the water vapor in the turbine exhaust gas to condense; and

a separator operatively associated with the absorption chiller, wherein the separator removes at least a portion of the condensed water from the exhaust gas.

2. The system of claim **1** wherein the absorption chiller is primarily powered by the heat energy of the exhaust gas in the exhaust duct.

3. The system of claim **1** further including a discharge conduit extending from and in fluid communication with the absorption chiller, wherein the discharge conduit routes the gas out of the absorption chiller.

4. The system of claim **3** wherein the discharge conduit is in fluid communication with the exhaust duct, whereby the gas is returned to the exhaust duct.

5. The system of claim **3** further including a blower provided along the discharge conduit, whereby the blower facilitates the movement of the gas along the discharge conduit.

6. The system of claim **3** further including a heat exchanger, wherein the supply conduit and the discharge conduit pass in heat exchanging relation through the heat exchanger such that the temperature of the gas in the supply conduit is reduced prior to entering the absorption chiller, whereby the effective duty of the absorption chiller is reduced.

7. A water recovery system comprising:

an exhaust duct with a turbine exhaust gas flowing therein, the turbine exhaust gas including water vapor and being at a first temperature;

a direct contact heat exchanger having an inlet and an outlet, each of the inlet and the outlet being in fluid communication with the exhaust duct, a portion of the turbine exhaust gas being received in the inlet, the direct contact heat exchanger having an upper end and a lower end, wherein the lower end is defined at least in part by a sump; and

at least one water dispensing device provided in the direct contact heat exchanger near the upper end, the at least one water dispensing device being adapted to introduce water into the flow of the turbine exhaust gas, wherein the water engages the exhaust gas so as to reduce the temperature of the exhaust gas so as to condense at least a portion of the water vapor in the exhaust gas, wherein the water collects in the sump.

8. The system of claim **7** wherein the direct contact heat exchanger is substantially vertical, wherein the outlet is provided vertically higher than the inlet.

9. The system of claim **7** further including a damper operatively associated with the outlet of the direct contact heat exchanger, wherein the damper can selectively regulate the flow of the gas through the outlet.

10. The system of claim **7** further including:

a return conduit in fluid communication with the sump and the at least one water dispensing device, wherein the return conduit routes water from the sump to the at least one water dispensing device for introduction to the turbine exhaust gas in the direct contact heat exchanger; and

a heat exchanger provided along the return conduit for reducing the temperature of the water to no more than about the ambient dry bulb temperature.

11. The system of claim **10** wherein the heat exchanger is a fin-fan cooler.

12. The system of claim **10** further including a pump provided along the return conduit, whereby the pump facilitates the flow of water through the return conduit.

13. The system of claim **10** wherein the return conduit includes a branch conduit, wherein the branch conduit is located upstream of the heat exchanger, whereby water can flow into the branch conduit for use elsewhere.

14. The system of claim **13** wherein the branch conduit is in fluid communication with a storage tank, whereby water is stored therein for later use.

15. The system of claim **13** further including a control valve provided along the branch conduit, wherein the control valve selectively permits and prohibits flow of the water through the branch conduit.

16. The system of claim **15** further including a sensor for activating and deactivating the valve, wherein the sensor is connected to the sump so as to be responsive to the level of the water in the sump, and wherein the sensor is operatively associated with the control valve such that the sensor activates the control valve when the level of the water in the sump reaches a predetermined level.

17. A stack water recovery system comprising:

an exhaust duct with a turbine exhaust gas flowing therein, the turbine exhaust gas including water vapor and being at a first temperature;

a separator;

a supply conduit extending between and in fluid communication with the exhaust duct and the separator, wherein the supply conduit receives a portion of the turbine exhaust gas and routes the gas to the separator;

a discharge conduit extending between and in fluid communication with the separator and the exhaust duct, wherein the gas in the discharge conduit reenters the exhaust duct for release into the atmosphere;

a first heat exchanger provided along the supply conduit upstream of the separator, wherein the supply conduit and the discharge conduit pass in heat exchanging relation through the first heat exchanger, and wherein the first heat exchanger reduces the temperature of the exhaust gas in the supply conduit below the first temperature; and

a second heat exchanger provided along the supply conduit downstream of the first heat exchanger and upstream of the separator, wherein the second heat exchanger further reduces the temperature of the turbine exhaust gas to a temperature below the dew point of the gas, thereby causing at least some of the water vapor in the turbine exhaust gas to condense, wherein the separator removes at least a portion of the condensed water from the gas.

18. The system of claim **17** wherein the second heat exchanger is a fin-fan cooler.

19. The system of claim **17** further including:

a storage tank; and

a conduit extending between and in fluid communication with the separator and the storage tank, wherein the water is routed to the storage tank for later use.

20. The system of claim **17** further including a blower provided along the discharge conduit.

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